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The preceding end transited 1891, June 3^{d} 15^{h} $11^{m}\cdot 7$, giving $\lambda = 16^{\circ}\cdot 9$.

The two principal members of the system of small dark red spots which were visible last year on the northern edge of the equatorial belt, and which I have designated as spots 1 and 2, have been regularly observed and measured this year. Though not as conspicuous as when seen in April of last year, they are very distinct, and of a deep red colour. Last year the measures did not indicate with certainty any relative motion in the two. This year, however, the distance between them has diminished considerably—about 2″. The latest observations show that the distance reached a minimum in the end of August, and seems now to be slowly increasing.

Mean distance 1890 . . .	7″·64
Mean distance 1891 . . .	5·58

I have collected my observations made of these spots this year in the following table, where Δ is the observed distance between them and Δ 5·20 the value at *Jupiter's* mean distance. The measures under the headings N and S are the measured distances from the north and south limbs of the planet.

Since the first observations of these spots in 1890 April 26, they have slowly drifted through 104° of longitude at the rate of 0°·253 daily. They will make a complete revolution about *Jupiter* in 3·9 years.

	Spot 1.	λ	Spot 2.	λ	Δ	Δ 5·20	N.	N. 5·20	S.	S. 5·20
1891	h m	°	h m	°	″	″	″	″	″	″
July 4	12 33	259·9	...	...	7·4	6·4	15·9	13·7	25·6	22·1
28	12 9	254·1	12 43	257·2	8·2	6·6	17·7	14·2	26·8	21·6
Aug. 9	12 1	254·1	...	...	7·0	5·5	17·8	14·0	27·5	21·6
14	...	...	11 35·1	270·2	6·5	5·1	17 7	13·8	28·5	22·2
19	10 11·9	252·2	...	...	7·3	5·2	...	...	...	...
24	...	...	9 41·6	265·7	6·0	4·6	...	...	...	...
Sept. 7	10 42·3	248·1	...	...	6·7	5·1	18·2	13·9	28·3	21·6
9	...	...	12 51·1	266·6	...	...	...	...	...	...
17	10 39	244·9	...	...	7·0	5·4	18·3	14·0	29·5	22·6
26	...	...	11 41·1	261·6	7·3	5·7	18·6	14·5	29·3	22·7
Oct. 3	11 58·2	243·0	...	...	7·8	6·1	...	...	...	...
4	7 42·1	238·8	8 13·1	257·5	7·2	5·7	17·7	13·9	27·6	21·8

Phenomena of the Satellites.

1891 July 11^{d} 13^{h} 39^{m} 6^{s}. Reappearance of II. from occultation. Bisection.

1891 July 27^{d} 12^{h} 53^{m} 43^{s}. Transit of II. egress. Bisection.

1891 August 10^{d} 13^{h} 59^{m} 24^{s}. Conjunction of I. and II.

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The two satellites appeared like a close double star, but well separated.

1891 August 12d 11h 58m 13s. Central transit of III. It crossed the bright surface of *Jupiter* as a large dark grey spot. The following are measures of its position at mid-transit:—

From South limb . . .	11″·7
From North limb . . .	34·0

1891 August 12d 12h 5m 12s. Reappearance of II. from occultation. Bisection.

1891 August 21d 8h 58m 33s. Transit II. egress. Bisection.

1891 Oct. 1d, between 9h and 10h. III. in transit as a dark spot.

1891 October 6d 6h 42m 25s. Transit I. egress. Bisection.

1891 October 6d 7h 13m 13s. Transit, egress IV. Bisection. Position at 6h 22m·2.

From North limb . . .	36″·2
From South limb . . .	8·6

It appeared as a large very dark spot, and was dark up to the moment of egress.

Phenomena of the First Satellite.

The first satellite has been observed on all favourable occasions with the 12-inch, to determine, if possible, the explanation of the phenomenon of 1890, September 8, when it appeared distinctly double at transit.

As I have previously remarked, the conditions for a reobservation of that phenomenon will not be suitable until at least 1892, since the satellite now transits the southern dark equatorial belt, and therefore cannot be seen dark in transit.

My observations have been confined principally to the 12-inch, the scale of which is too small to settle definitely the phenomena exhibited in the transits of the satellites. On several occasions I have, however, been able to examine the satellite in transit with the 36-inch refractor.

The phenomena seen on these occasions would rather discourage the idea of actual duplicity. At these times the satellite has appeared egg-shaped when in relief on the dark belt.

This elongation cannot be due to any malformation of the satellite, since that object has always appeared perfectly round only a few minutes before the elongated phase, the transition being rather sudden. I am confident that this particular phase, and perhaps also that of apparent duplicity, is explained by a bright belt on the satellite, or by darkness of its polar regions, which is the same thing. This I have explained in a previous communication (*Monthly Notices*, vol. li, 557). I cannot, however, account for the egg-shaped appearance of the satellite, unless it be due to a local excursion of the darker polar caps towards the equator of the satellite. If such is the case, I. must rotate on its axis in a time different from that of its period of revolution, as I have seen this pointed or wedge-shaped appearance sometimes preceding and at other times following the centre of the satellite, at observations separated by no great intervals, and this in the same position on the disc of *Jupiter* (1891 August 3, small end preceding. September 11, small end following. September 18, small end following).

At times this elongation is perfectly parallel to the belts of *Jupiter*; at other times it is inclined 7° or 8° to them. In my previous communications on this subject I have spoken of the position angle of apparent duplicity or elongation. I should have stated that these position angles were referred to the north pole of *Jupiter*, and not to a celestial meridian.

Following are notes with reference to the subject in hand :—

1891 July 4^{d} 13^{h} 27^{m} 13^{s}, with the 12-inch, the first satellite bisected at transit egress. Before emergence it was seen as a dusky spot, apparently round. At last contact it was certainly perfectly round.

1891 July 11, with the 12-inch. Carefully watched for a dark transit of I. After entering some distance, the satellite entirely disappeared, blending into the dark belt. Its shadow was black and round when well on the disc. At 15^{h} the satellite was visible as a small pale white spot on the south belt.

1891 July 27, with the 12-inch. Carefully watched the satellite. It became visible as a very faint dark spot when about one-fifth across. At 12^{h} 13^{m} it was near the middle of its path. It was impossible to make out its form, since the contrast was too small. The shadow was round.

1891 August 3. The satellite observed in transit with the 36-inch. Shadow was large and round when well on the disc at $13^{h}\frac{1}{2}$. I. was very much elongated. It was egg-shaped, the small end preceding. Position angle (from Jupiter's north pole) 265°±. The observations on this date have already been sent to the *Monthly Notices*.

1891 September 4. 36-inch. The satellite transited partly covering its shadow. It could not be seen when in mid-transit, but became visible when about four-fifths across. It then appeared perfectly round and partly overlapped its shadow, which appeared as a crescent, joining the north preceding side of the satellite. There was no marking of any kind visible on I., which was watched until egress. Mr. Burnham observed the transit with me.

1891 September 11. 36-inch. Mr. Burnham and I carefully examined I. in transit. The seeing was very poor, but occasionally, during moments of good definition, the satellite was decidedly elongated to both of us. It was egg-shaped with the small end following. The elongation was parallel to the belts of

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Jupiter. These observations were made when the satellite was one-fourth across. It was examined again when about four-fifths across. The elongation and egg-shaped appearance were the same, but the seeing had become so poor that its form could not be clearly distinguished at exit.

1891 September 18. 36-inch. Mr. Burnham and I examined the satellite in transit. Before entrance it was perfectly round, and there seemed to be a small dark spot in its centre, which may have been optical. It remained round for a short time after entering upon the planet, but when about one-sixth across, it became elongated in a line perfectly parallel with the belts of *Jupiter.* The elongation was conspicuous. Both Mr. Burnham and myself agreed as to the rapid transition from a round to an elongated object. The following end of the satellite was unquestionably the smaller. The elongation was as nearly as may be 2×3. Watched it closely from the time of contact at entrance until $0^h\ 20^m$ sidereal. Seeing $=4$. During this time, II. following the planet was round.

1891 October 3. 12-inch. The satellite was examined before transit, when it was perfectly round; it was also round at entrance. It soon became lost in the dark belt. The scale of the 12-inch was too small to be certain of its form when disappearing, but it seemed to be elongated. Bisection at entrance $10^h\ 1^m\ 41^s$. The seeing was perfect.

The Nature of the Surface of Jupiter.

After observing the planet for some twelve years I can hardly advocate the theory that the visible surface of *Jupiter* is a cloud surface.

It would seem to me more consistent with the observed phenomena to suppose the surface to be in a plastic or pasty condition, the belts and markings being merely discolorations in this, due to internal eruptions. This would easily account for the observed permanence of certain of the markings and for their colours. I do not think the cloud theory can account at all satisfactorily for the continued permanence of the various markings. The colours and changes of colour are also against it. If we assume the plastic theory, it is readily seen how the dark markings may be matter brought up to the surface by internal disturbances, and which by exposure on the surface is subject to changes of form and colour. Or possibly one might combine the two theories, and account for any shortcomings in the plastic theory by supposing local clouds of steam near or on the surface. I do not know to what extent the small density of the planet may militate against this, but the theory certainly seems worthy of consideration.

Perhaps this idea has been advanced before, as it seems a natural one: if so, I have not seen it.

Mount Hamilton:
1891 *October* 9.

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On the supposed Duplicity of the First Satellite of Jupiter.
By A. Stanley Williams.

With reference to the remarkable apparent duplicity of the First Satellite of *Jupiter* observed by Mr. Barnard on September 8, 1890, and of which he gives an account in the *Monthly Notices*, vol. li., p. 547, I would ask whether it is quite certain that the observed phenomenon may not have been due to the satellite being seen in transit as a dark spot close to a dark spot on the surface of *Jupiter*. Such an explanation would, of course, be out of the question in the case of an observer of so much experience as Mr. Barnard, if the observation could have been continued during a considerable part of the time that the satellite was on the disc of the planet, since the difference in the rate of motion of the two spots could not in such case have escaped being noticed. But Mr. Barnard expressly states that the observation was interrupted, and that it was not possible to follow the satellite closely owing to the presence of visitors. And the explanation now suggested assumes greater probability when considered in connection with the observation referred to below, since it will appear that there was actually a little spot on the surface of the planet exactly in the position necessary to give rise to the observed duplicity. The explanation ingeniously set forth by Mr. Barnard in his note on p. 557 of vol. li. of the *Monthly Notices* appears to me inadequate to account for the observed appearance, since it would require the satellite to be much larger than it actually is.

On September 5, 1890, three days before Mr. Barnard's observation, *Jupiter* was observed by the writer with a 6½-inch Calver reflector, powers 150 and 225. A little dark spot was noticed in the middle of the bright equatorial zone, exactly in the position of the southernmost component of the double spot represented by Mr. Barnard in his figure (Plate 14, fig. 4). The spot was slightly oval in shape, and about $1''$ in length. It was observed to be in mid-transit at $8^{h}\ 42^{m}{\cdot}8$. It therefore followed the zero meridian of System I. of Mr. Marth's Ephemeris (*Monthly Notices*, vol. l., p. 346), by $3^{h}\ 30^{m}{\cdot}7$. The motion of the markings in the equatorial region of *Jupiter* agreed closely last year with this ephemeris, so that in an interval of a few days there would be no appreciable difference.[*] The little dark spot would therefore have transited at $15^{h}\ 26^{m}{\cdot}7$ G.M.T. on September 8. According to the *Nautical Almanac* the

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[*] The above spot was so small and delicate that, in the unfavourable position of the planet last year, it could not be continuously observed. But a little preceding it was another similar, but larger and plainer, spot, and the